

Climate Change Effects on Forest Carbon



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**Adaptation Planning and Practices for Water Supply Reservoir
Forests in the Mid-Atlantic**

North Point State Park, MD | January 30, 2020

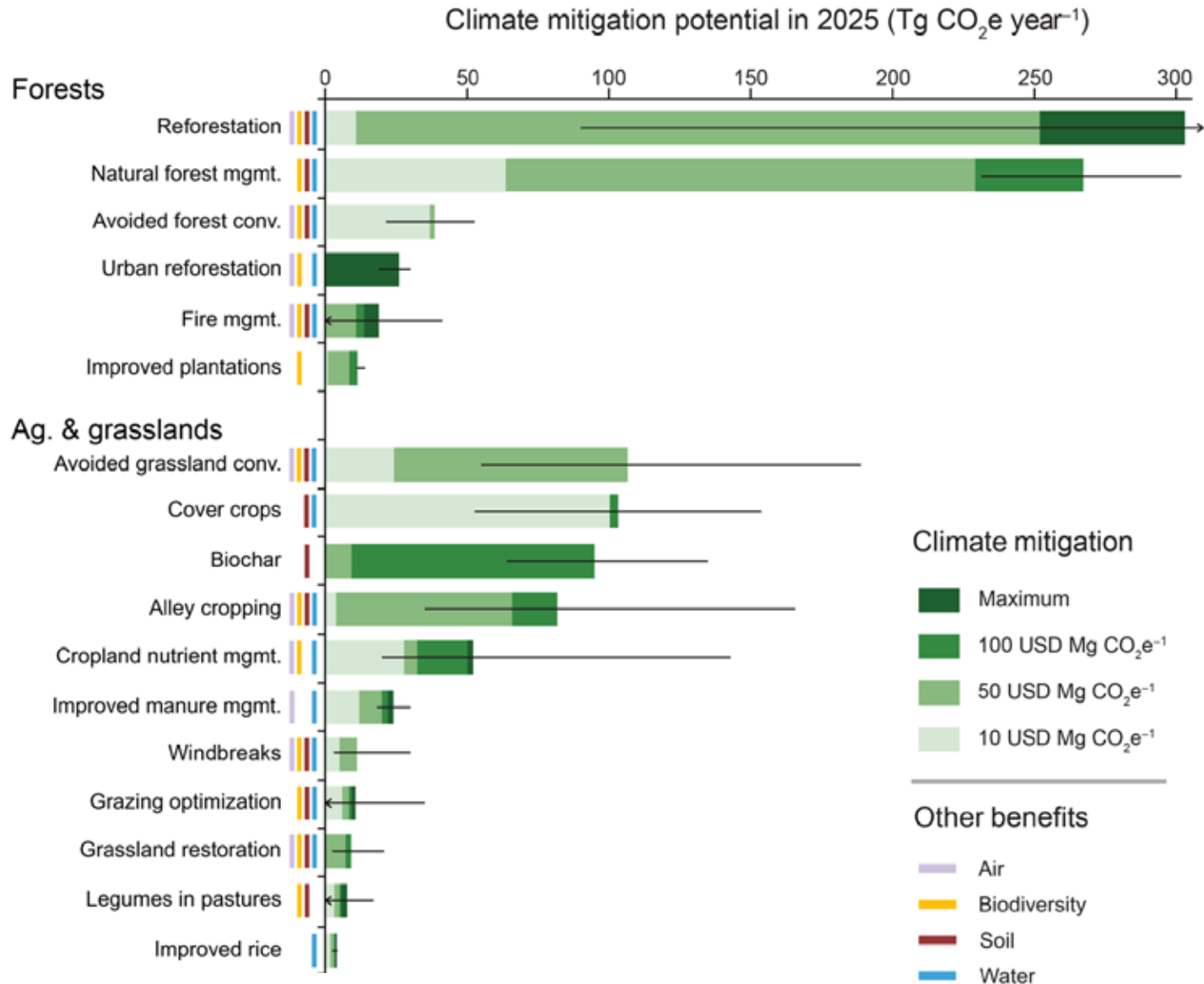


US forests:

- Absorb **15%** of CO₂ emissions from fossil fuels
- Contain **68%** of terrestrial carbon stocks
- Represent **90%** of land sector sequestration capacity



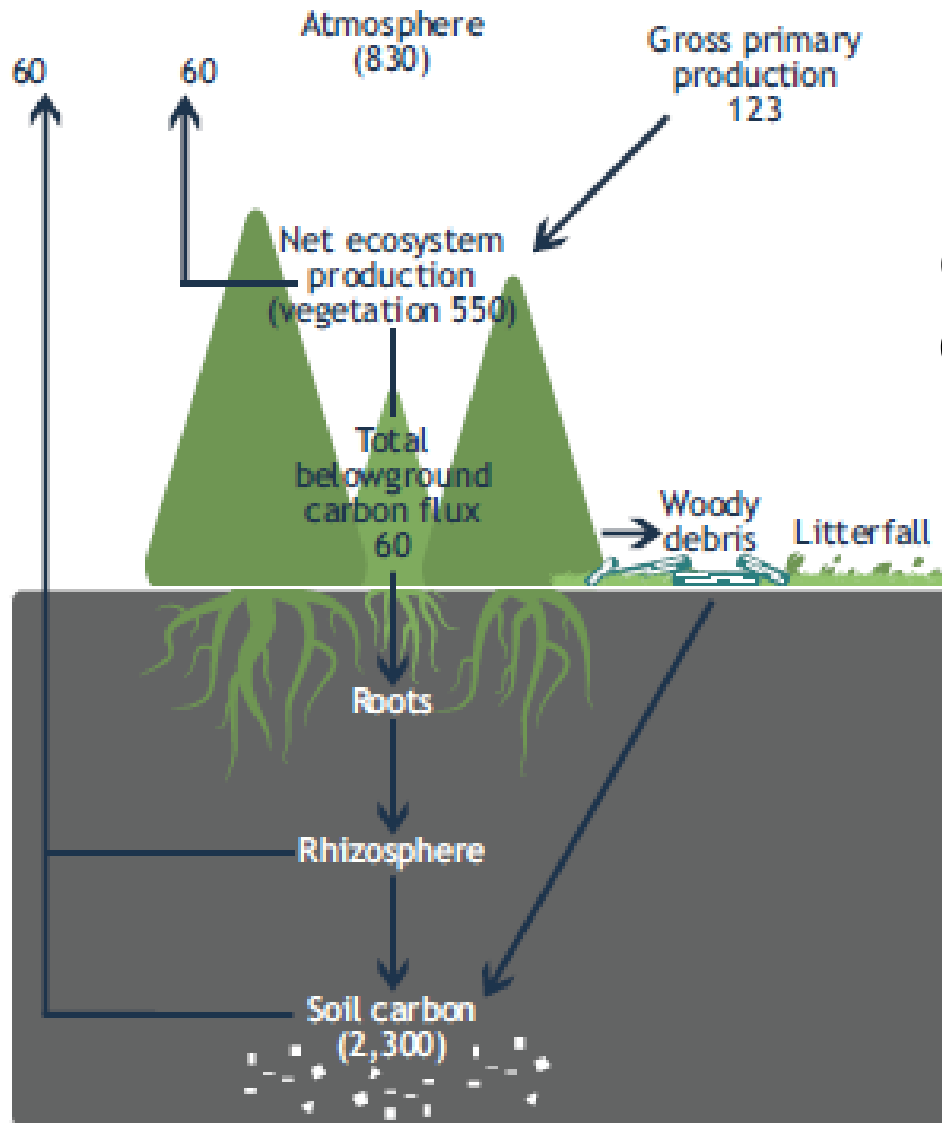
Natural Climate Solutions



A changing climate puts those forests and the carbon they sequester at risk



Effects on Forest Carbon



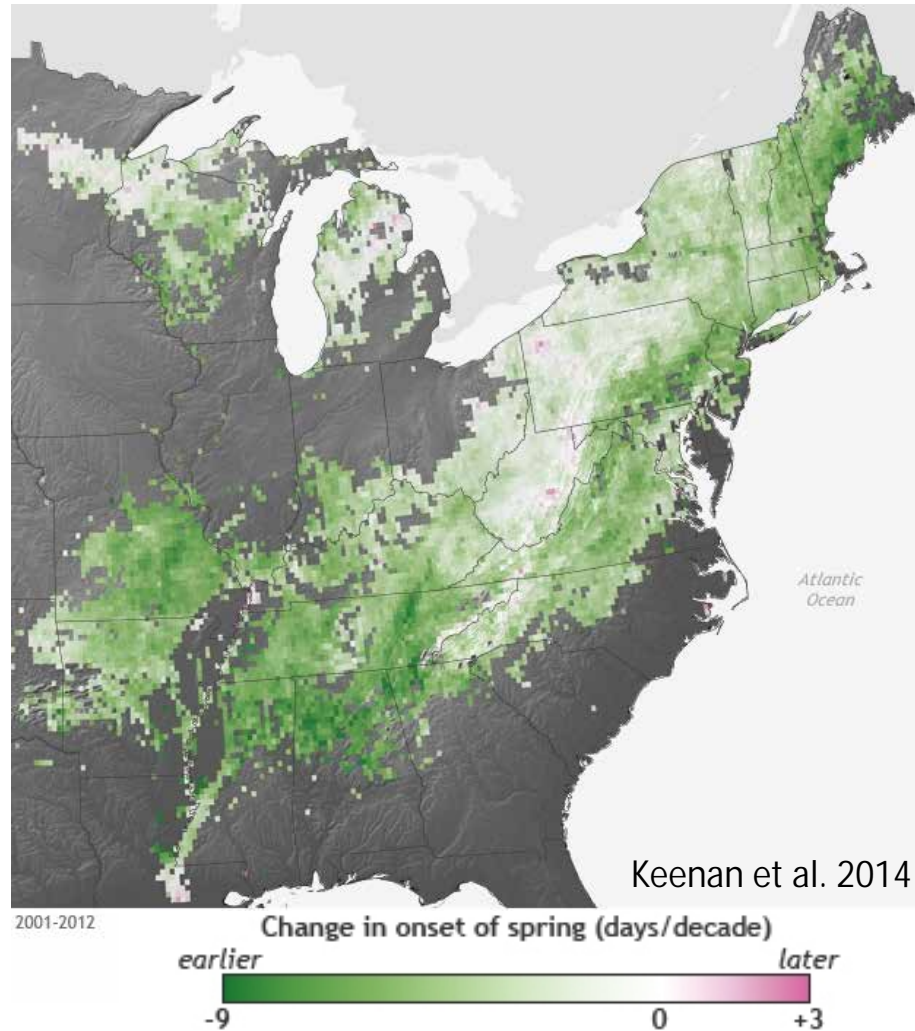
Climate change impacts forest carbon through effects on:

- Carbon sequestration (forest productivity)
- Carbon storage (biomass in trees, roots, soil)

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

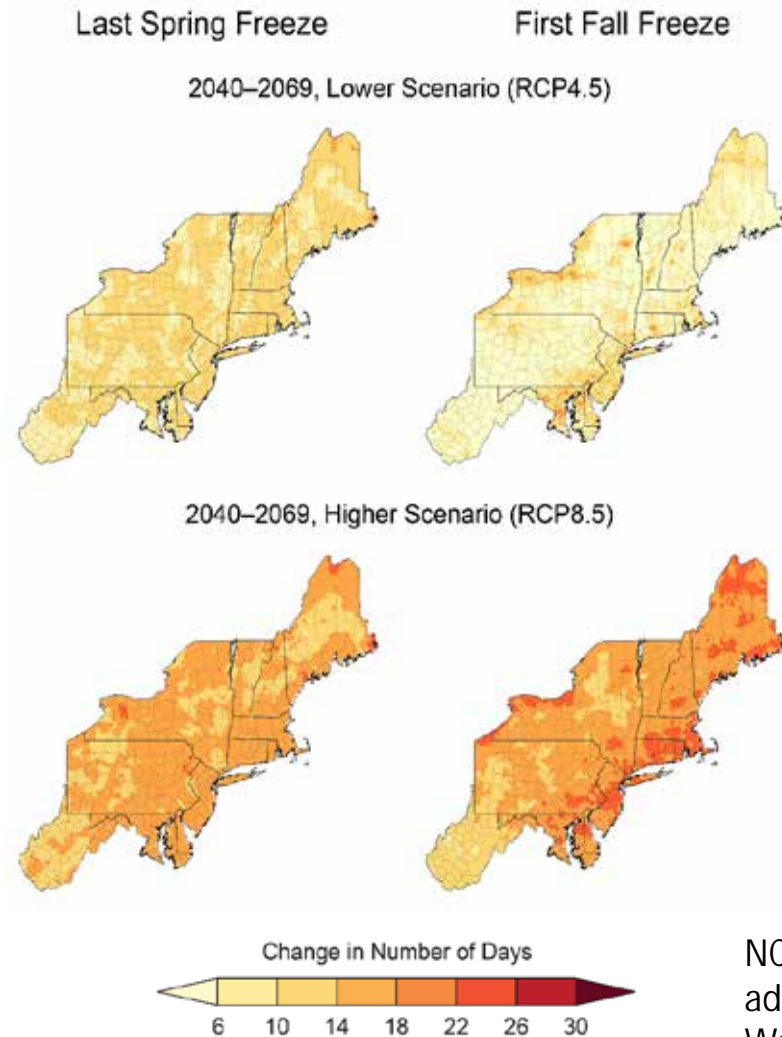
THE GOOD:
Longer growing seasons.



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:
Longer growing seasons.



NCA 2018;
adapted from
Wolfe et al. 2018

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:
Longer growing
seasons
mean
more carbon
uptake in
forests.

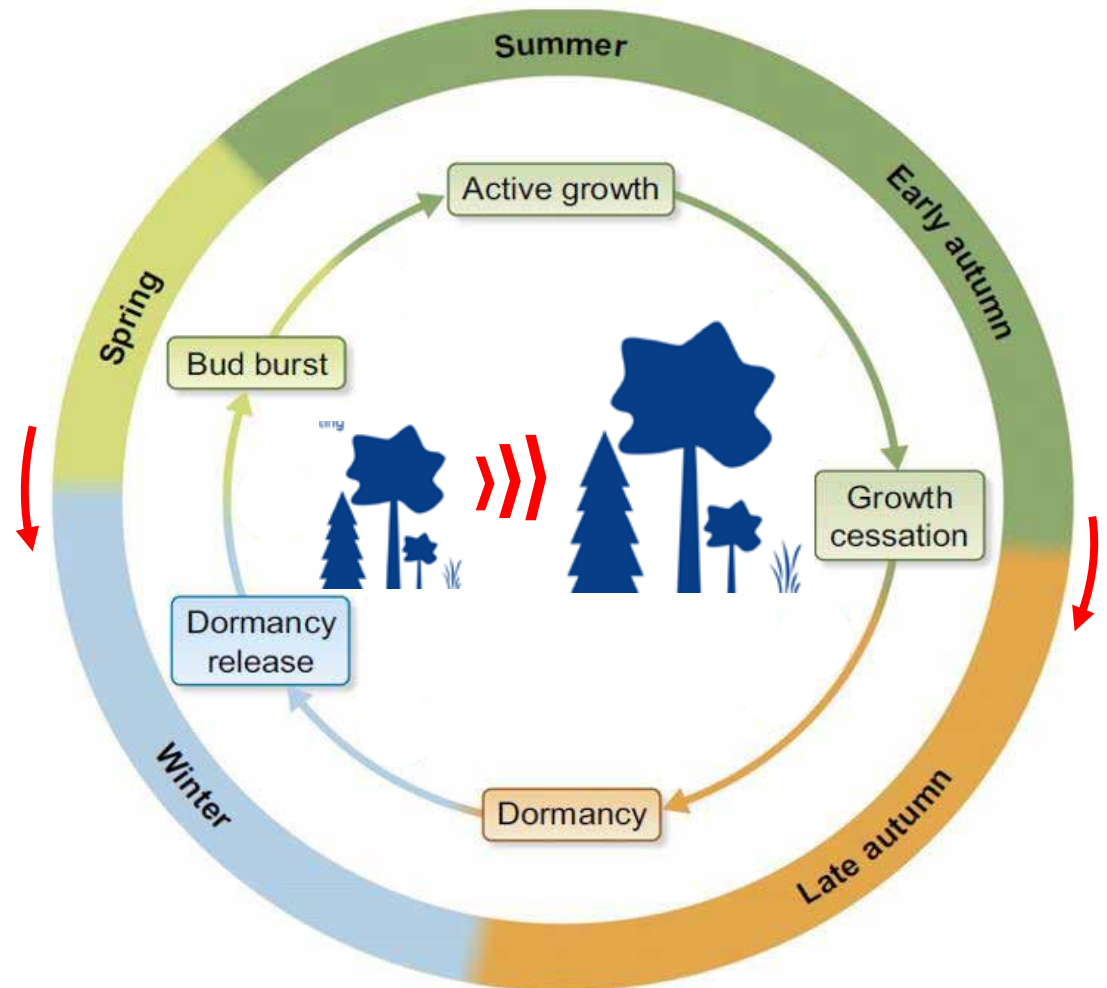


Figure from Singh et al. 2017

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:

Longer growing seasons.

THE BAD:

Shorter, warmer winters.

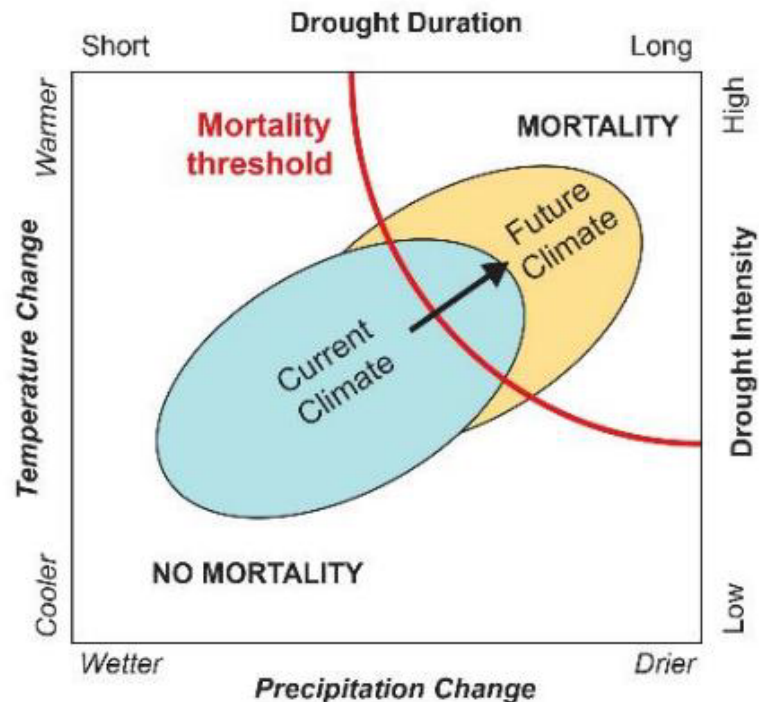


Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE BAD:
Shorter, warmer
winters.

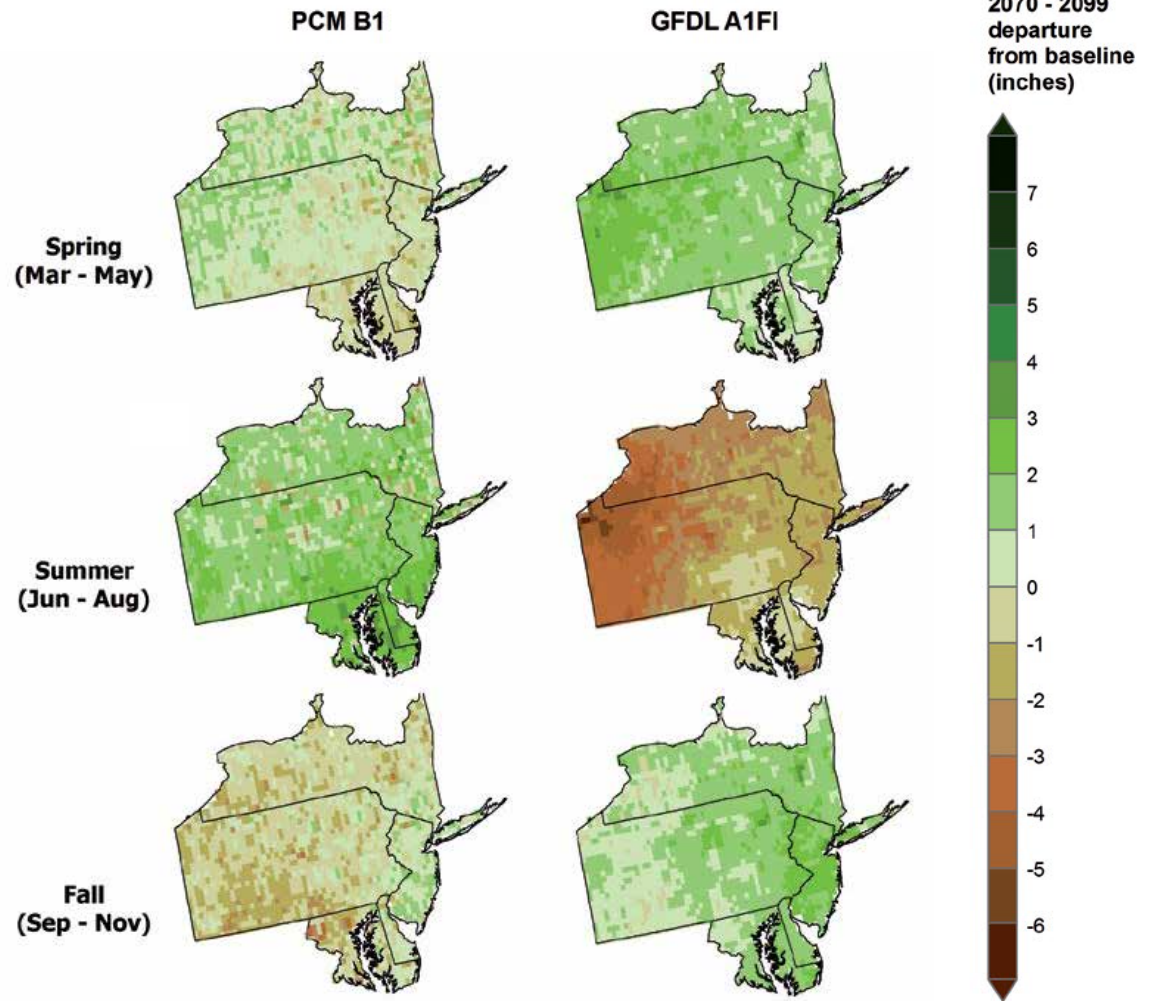
Drier conditions & drought
Warmer temperatures drive moisture
deficits



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE BAD:
Shifting
precipitation
patterns



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE BAD:
Soil moisture
stress



RESEARCH ARTICLE | ECOLOGY

Increased atmospheric vapor pressure deficit reduces global vegetation growth

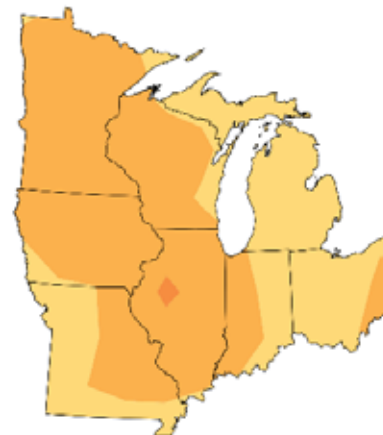
Wenping Yuan^{1,2,*}, Yi Zheng¹, Shilong Piao³, Philippe Ciais⁴, Danica Lombardozzi⁵, Yingping Wang^{6,7}, Youngryel Ryu⁸, Guixi...

+ See all authors and affiliations

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Projected Increases in Vapor Pressure Deficit

(b) Lower Scenario (RCP4.5)

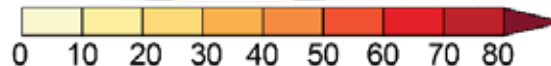


(c) Higher Scenario (RCP8.5)



Angel et al.
2018

Percent Change



Higher values = drier plants and soils

Impacts on tree health, productivity,
forest regeneration, ...

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:

Longer growing seasons.



THE BAD:

Shorter winters, drier conditions.



THE UGLY:

More extreme events.



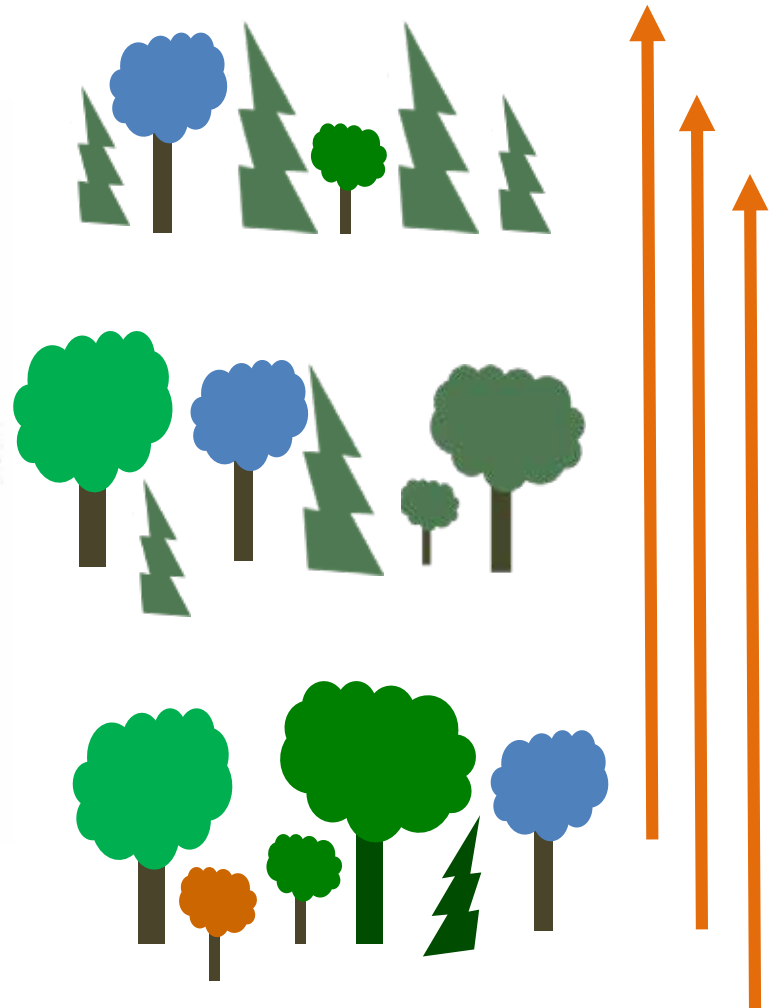
Effects on Forest Carbon

SHIFTING SEASONS | **SHIFTING SPECIES** | SHIFTING STRESSORS

Many northern species are projected to decline in the region.

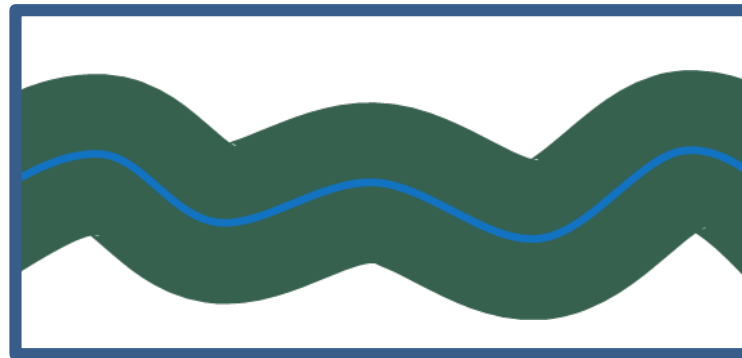


Many species common farther south are expected to see increased or new habitat.



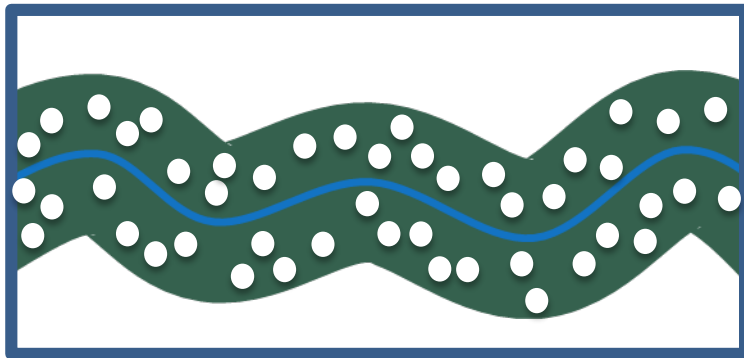
Effects on Forest Carbon

SHIFTING SEASONS | **SHIFTING SPECIES** | SHIFTING STRESSORS

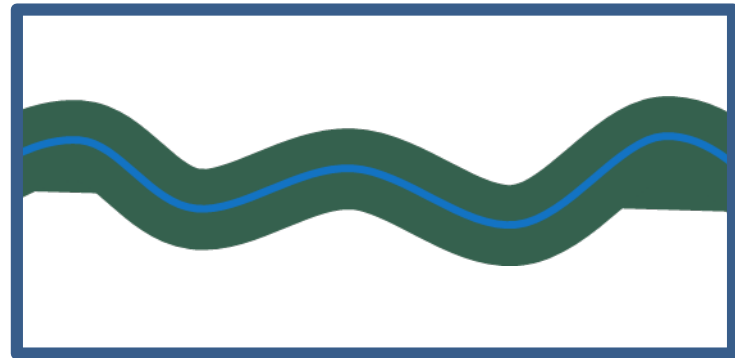


 = suitable habitat

50% Reduction in Habitat:



Habitat reduced equally



Best habitats remain

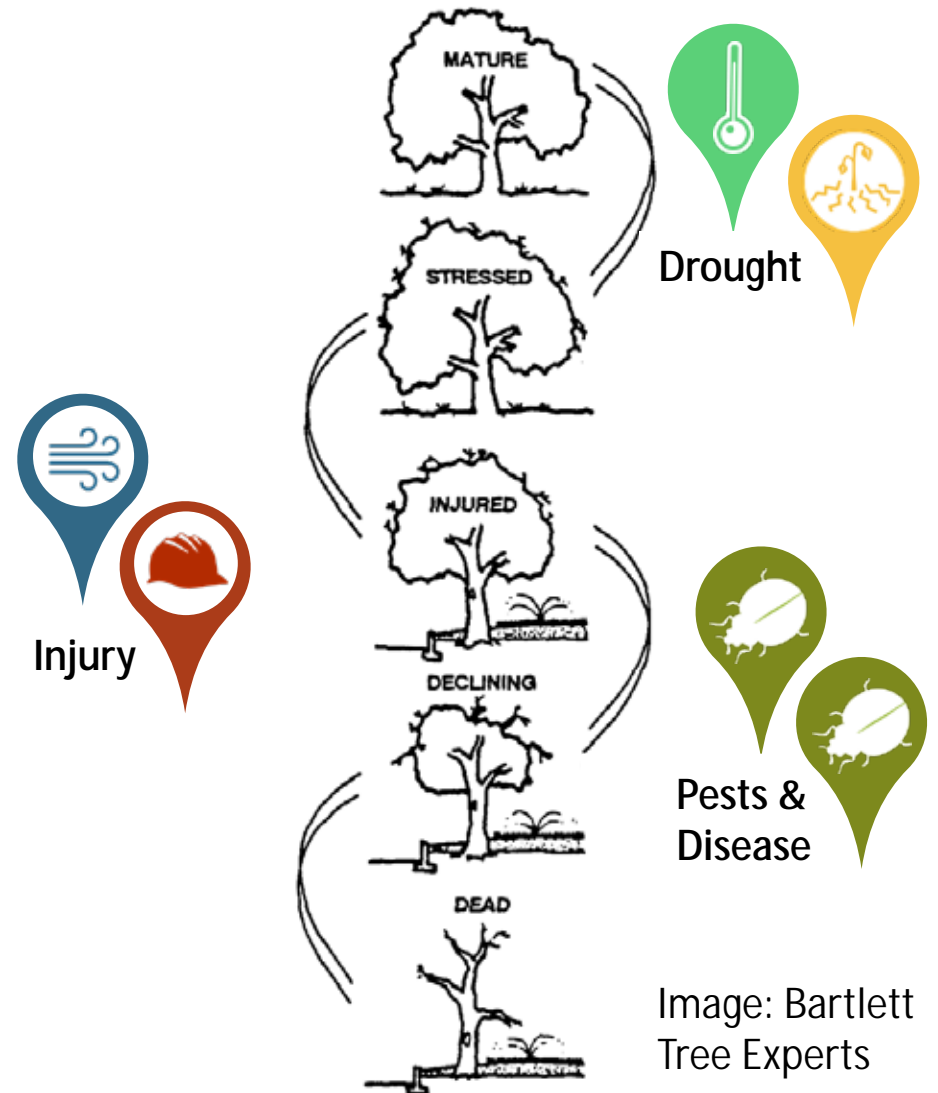
Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | **SHIFTING STRESSORS**

Climate change is a “threat multiplier”.

- Chronic stress
- Disturbances
- Insect pests
- Forest diseases
- Invasive species

Interactions make all the difference.



Practitioner's Menu of Strategies & Approaches for Forest Carbon Management



www.forestadaptation.org/carbon

Ontl et al. 2019. Forest management for carbon sequestration and climate adaptation. *Journal of Forestry* 118(1): 86-101.

Journal of
FORESTRY



Synergies between Mitigation & Adaptation



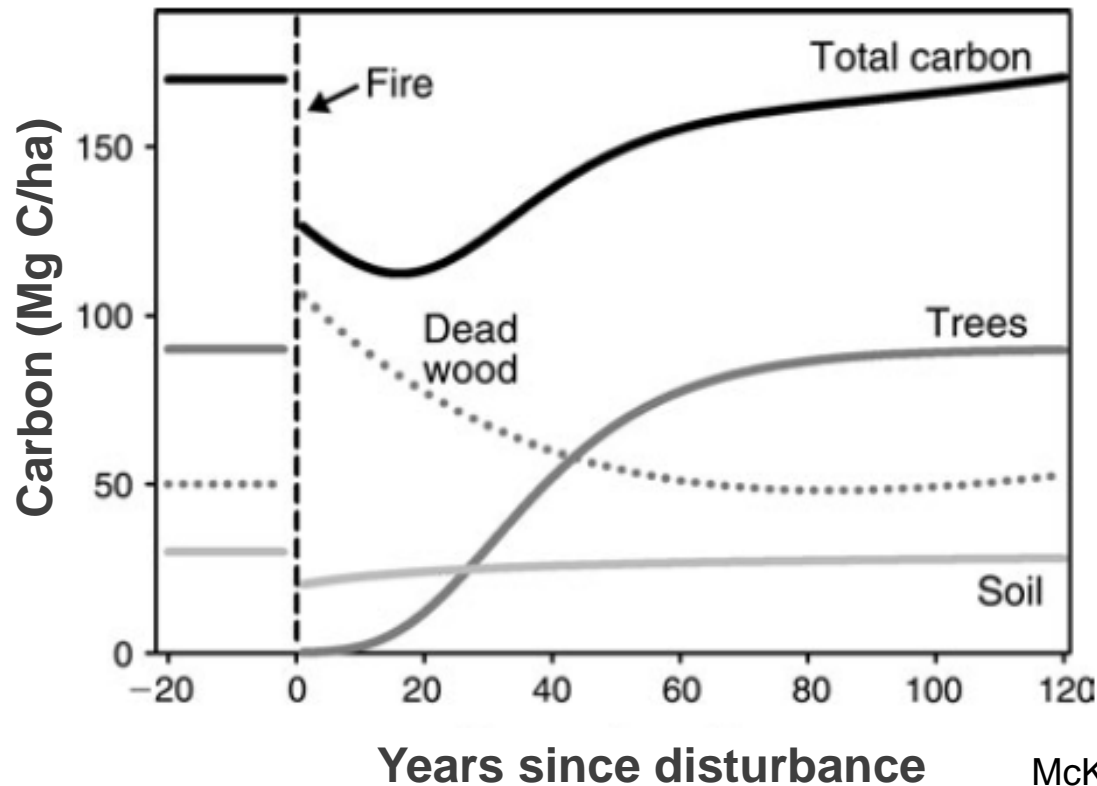
Adaptation

Mitigation



Synergies between Mitigation & Adaptation

Considering extended time-scales can reveal synergies between adaptation and mitigation



McKinley et al. 2011

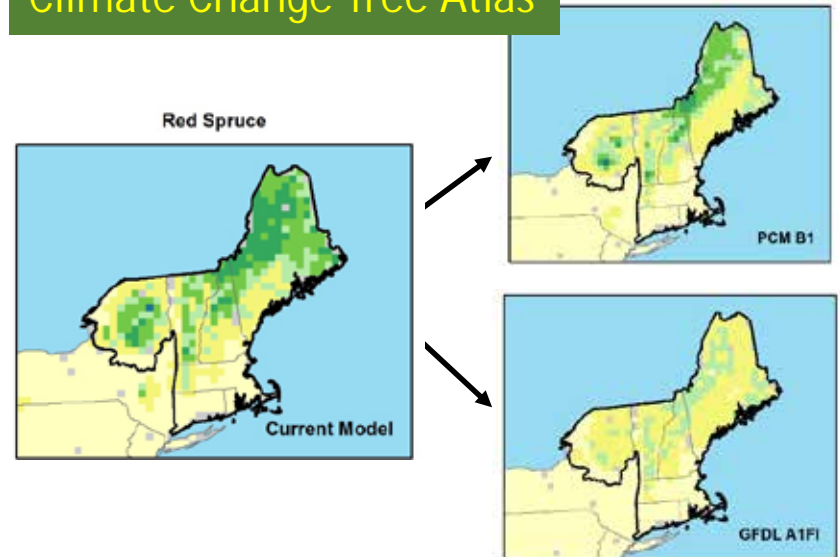
Synergies between Mitigation & Adaptation

Consideration of climate vulnerability may increase the effectiveness of management actions on enhancing forest carbon



Adler Fire, Yellowstone NP (NPS)

Climate Change Tree Atlas



www.nrs.fs.fed.us/atlas/tree/

Synergies between Mitigation & Adaptation

Carbon is often one of many desired forest benefits



Forest Carbon Management Menu

Strategies

1. Maintain or increase extent of forest ecosystems.
2. Sustain fundamental ecological functions.
3. Reduce carbon losses from natural disturbance, including wildfire.
4. Enhance forest recovery following disturbance.
5. Prioritize management of locations that provide high carbon value across the landscape.
6. Maintain or enhance existing carbon stocks while retaining forest character.
7. Enhance or maintain sequestration capacity through significant forest alterations.

Forest Carbon Management Menu

Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character

6.1 Increase structural complexity through retention of biological legacies in living and dead wood

6.2 Increase stocking on well-stocked or understocked forest lands

6.3 Increase harvest frequency or intensity due to greater risk of tree mortality

6.4 Disfavor species that are distinctly maladapted

6.5 Manage for existing species and genotypes with wide moisture and temperature tolerances

6.6 Promote species and structural diversity to enhance carbon capture and storage efficiency

6.7 Use seeds, germplasm, and other genetic material from across a greater geographic range



Forest Carbon Management Menu

Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character

6.1 Increase structural complexity through retention of biological legacies in living and dead wood

Examples of adaptation tactics are:

- Retaining the oldest and largest trees with good vigor during forest management activities
- Retaining survivors of pest and disease outbreaks, droughts, windthrow events, or other disturbances during salvage operations
- Retaining down logs, snags, and other dead wood during forest management, or leaving trees of poor health that are expected to contribute to dead wood pools
- Not salvage logging where risks from fires or to forest health are low



Forest Carbon Management Menu

EQIP PRACTICE: PRESCRIBED BURNING 338

Strategy 3: Reduce carbon losses from natural disturbance, including wildfire

Approach 3.1 Restore or maintain fire in fire-adapted ecosystems

Approach 3.2 Establish natural or artificial fuelbreaks to slow the spread of catastrophic fire

Approach 3.3 Alter forest structure or composition to reduce the risk, severity, or extent of wildfire

Approach 3.4 Reduce the risk of tree mortality from biological or climatic stressors in fire-prone systems

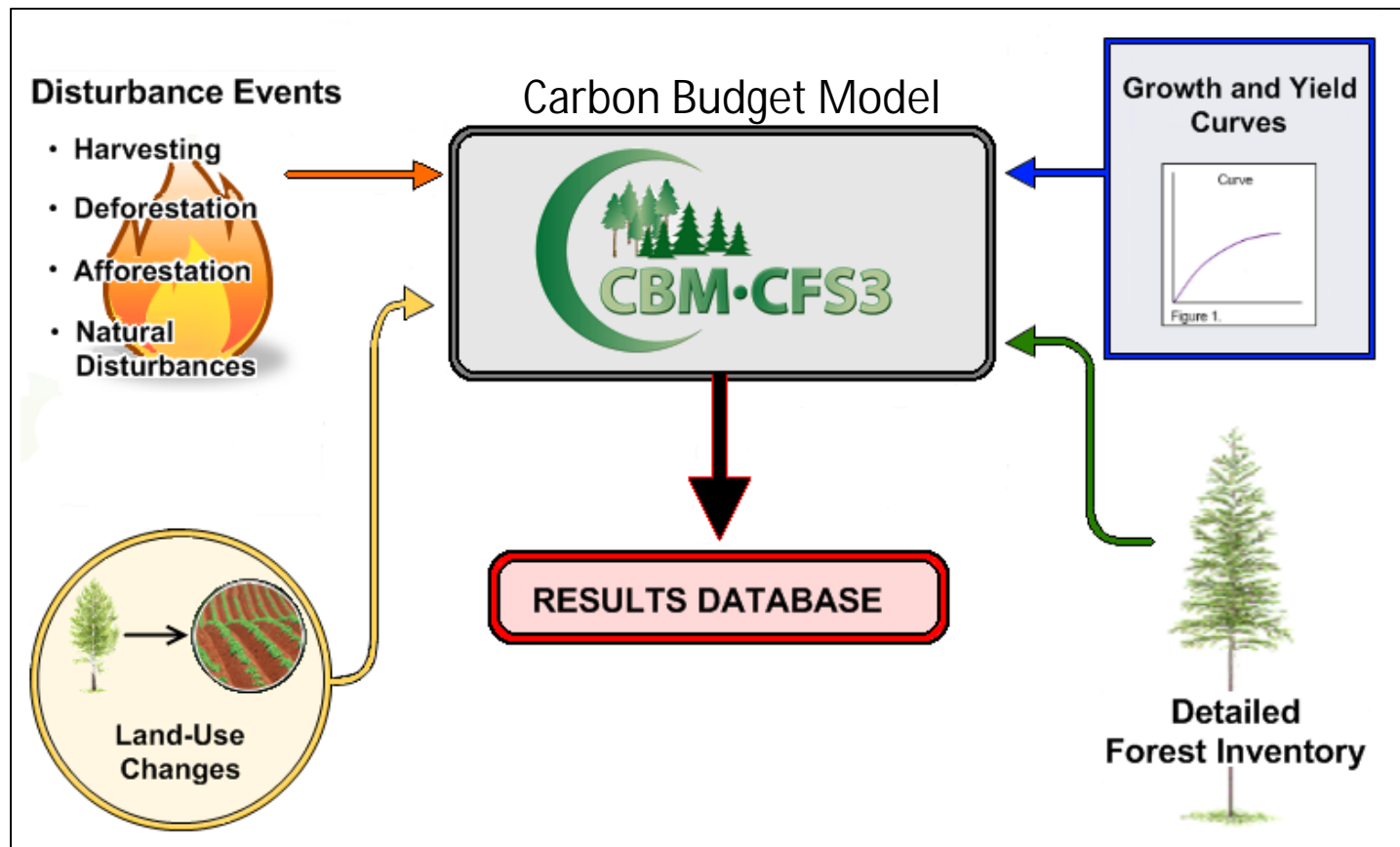
Approach 3.5 Alter forest structure to reduce the risk, severity, or extent of wind & ice damage



Questions?



Impact of Forest Management on Carbon Sequestration and Storage in Pennsylvania and Maryland



What forest management & adaptation practices should we include?

- Controlling invasive species and vines
- Managing deer browse
- Thinning overstocked stands
- ...
- [Insert your idea here]

Please tell me what you think!

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AMERICAN FORESTS
- SINCE 1875 -



Thank you!

Kendall DeLyser

kdelyser@americanforests.org



Increase on-site carbon storage

Conservation Practice 666: Forest Stand Improvement

Strategy	Approach	Tactic (from CSP)
Strategy 2: Sustain fundamental ecological functions	2.1 Reduce impacts to soils and nutrient cycling	Close unneeded roads and limit off-road vehicular traffic to avoid displacing the forest litter layer.
Strategy 2: Sustain fundamental ecological functions	2.1 Reduce impacts to soils and nutrient cycling	Adopt techniques for maintaining and/or improving soil quality, specifically retention of organic carbon.
Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character	6.1 Increase structural complexity through retention of biological legacies in living and dead wood	Retain all snags and downed woody debris of 6" diameter or larger at the base.
Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character	6.1 Increase structural complexity through retention of biological legacies in living and dead wood	Identify leave-trees or clumps of trees that will be retained on site throughout their life span.
Strategy 7: Enhance or maintain sequestration capacity through significant forest alterations	7.2 Alter forest composition or structure to maximize carbon	Transition from even-aged to uneven-aged management.

Planting for high carbon sequestration rate

Conservation Practice 612: Tree/Shrub Establishment

Strategy	Approach	Tactic (from CSP)
Strategy 1: Maintain or increase extent of forest ecosystems	1.2 Reforest lands that have been deforested and afforest suitable lands	Trees and shrubs will be planted on selected areas within any land use.
Strategy 2: Sustain fundamental ecological functions	2.5 Reduce competition for moisture, nutrients, and light	Trees and shrubs will be planted in areas with adequate sunlight.
Strategy 4: Enhance forest recovery following disturbance	4.2 Restore sites with a diversity of species that are adapted to future conditions	Trees will be selected for their rate of growth and suitability for use in durable manufactured products <u>as well as their adaptability to site conditions.</u>
Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character	6.2 Increase stocking on well-stocked or understocked forest lands	Increase stocking levels in forests that are not fully stocked.